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LEASE VERSUS BUY DECISION MAKING
IN THE NAVY'S SATELLITE COMMUNICATIONS
SYSTEMS

by

Faruk ENGIN

June 1989

Thesis Advisor William R. GATES

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LEASE VERSUS BUY DECISION MAKING
IN THE NAVY'S SATELLITE COMMUNICATIONS SYSTEMS

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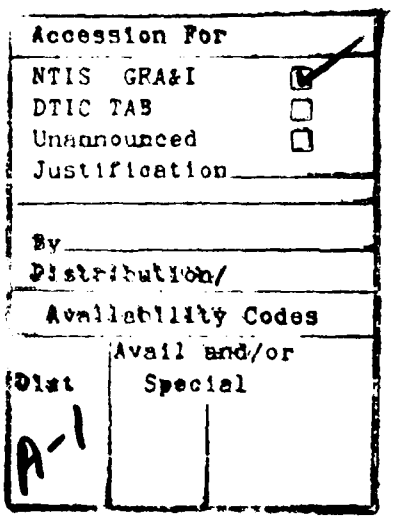
ABSTRACT

This study provides a general analysis of the United States (U.S.) Navy's lease versus buy decision model in the satellite communications systems. It also examines the Leased Satellite (LEASAT) and the Ultra High Frequency (UHF) Follow-on satellites. It gives general background information on lease versus buy decisions in both the public and private sectors. It evaluates the inputs affecting the lease/purchase decision, particularly the tax inducement and tax regulations affecting lease/buy decisions in the U.S. satellite communications sector. However, the analysis shows that cost considerations do *not* always receive top priority. Technical sophistication and risk, managerial considerations, and cash flow implications are among the other factors considered in lease/buy analyses.



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I. INTRODUCTION

Today, satellite communication is certainly one of the most influential factors affecting the world's ***business*** relationships, ***human*** relationships, and ***military*** effectiveness over other countries by making the distances closer between them. Thus, it can be said that satellite communication is a new horizon of changing concepts and fast growth.

Today, there are approximately 150 satellites in geosynchronous orbit, and this number is expected to grow to 300 by the 21st century [Ref. 1: p. 88]. The future of communications satellites has worldwide importance. Speculative assessments about future markets for communications satellites are varied and contradictory. Some people expect a decrease in the demand for telecommunication satellites, mainly because of developments in fiber optics technology. Others believe that there is in reality, gradually increasing demand for satellites. According to one forecast, the worldwide market for the information industry will be approximately $1.6 trillion by 1994 [Ref. 1: p. 92]. About half of this value will be in telecommunications. In spite of this forecast there exists no specific worldwide demand forecast for telecommunication satellite markets. Satellite transmission, compared to other transmission modes, is cheaper in areas of hard climate, sparse population, rough territory, and long transmission conditions. Since satellite technology is not easily affected by the transmission distance, this allows a low cost for long distance communication services. [Ref. 1]

A. OBJECTIVES

The purpose of this thesis is to analyze the present lease versus buy decision model for satellite communications systems in the United States. It will examine how recent changes in the U.S. tax laws have affected the decision model. The impact of these changes will be examined in the content

of the lease versus buy decisions in the Leased Satellite (LEASAT) program and the Ultra High Frequency (UHF) Follow-on communications satellites.

The main objectives of this study are as follows:

- Describe the lease and buy decision.
- Explain public and private sector leasing.
- Understand the advantages and disadvantages of leasing and buying in both private and government sectors.
- Identify the economic forces affecting the government and private sectors.
- Determine the effect of the 1986 changes in the tax regulations on the lease/buy decision.
- Describe the LEASAT program.
- Investigate the model used in the Navy's initial lease decision.
- Identify the factors leading the Navy to purchase the UHF Follow-on satellites.

B. ORGANIZATION

This thesis is arranged into chapters, each having specific objectives.

Chapter II, Background to the Lease versus Buy decision: provides the basic background information to give the reader a quick insight into this study. Specifically, it gives the general definition of lease and buy decisions. It also includes lease versus buy decision phenomena in both public and private sectors.

Chapter III, Factors Considered in a Lease versus Buy Analysis: presents the general arguments for and against leasing and buying. This chapter deals with three basic areas which the decision makers take into consideration in making an effective and best decision: technical performance, managerial aspects and financial conditions. Finally, it discusses the tax laws affecting the U.S. satellite communication sectors.

Chapter IV, Analysis of LEASAT: introduces the LEASAT Satellite Communications Systems and the UHF Follow-on system. It presents the LEASAT contract between the Navy and Hughes Aircraft Company, emphasizing the Navy's position in this contract. This chapter also describes

the Navy's lease versus buy model. Finally, it discusses the lease versus buy decision in the LEASAT and UHF Follow-on satellite program.

Chapter V, Conclusions: presents the conclusions and findings of this study.

II. BACKGROUND TO THE LEASE VERSUS BUY DECISION

A. DEFINITIONS

Several definitions will be provided before discussing the lease versus buy decision.

1. What is a buy?

By definition, *"to buy"* means getting something by paying its price by money or its equivalent: to purchase [Ref. 2]. At first thought, buying something may be considered so simple that everyone can do it as long as they can afford the price. However, the buying process for a complex item like a satellite communication system is not an easy procedure. To buy, in other words, being the owner of an asset, can take different perspectives in different media and in different occasions. Despite these different perspectives, the unique common result in a buying process is that the purchaser becomes the owner of the asset after making the appropriate payment.

Generally, the federal government's purchasing procedures introduce many complexities beyond just obtaining ownership of an asset. For example, buying a Military Satellite Communications System (MILSATCOM) in the U.S. obligates the military service to describe the system requirements first, and then explain its needs in meeting the Department of Defense (DOD) mission. Next the system must be included in the DOD budget. The last step is explaining the requirements for the system. These must be presented to Congress, an agency outside DOD. [Ref. 2: p. 13] This kind of acquisition procedure may vary from country to country.

2. What is a lease?

A lease is simply a contract for equipment or service between the lessee (*the leasing party*) and the lessor (*the owning party*). In other words:

> A lease is a form of contract that defines conditions of ownership and use for a specific asset. In the standard text book definition, leasing is an agreement that conveys to the lessee the right to use a specific property for a particular period of time in return for a stipulated (usually periodic) cash payment. These payments are made to the lessor, who holds the title or ownership rights to the leased property. [Ref. 3: p. 5]

As indicated above, the ***" title holder "*** of an asset owns the claim to the residual value of the asset at the termination of the lease. The residual claimant has the right to both profits and losses. As a consequence of this, the title holder of an asset enjoys any gains or suffers any losses resulting from increases or decreases in value, respectively. [Ref. 3: p. 5]

Figure 1 on page 6 shows a simple lease flow diagram [Ref. 2: p. 16]. This figure was drawn like a flow chart to emphasize the relationships of the participants involved in a lease process.

3. Types of leases

Leases may be observed in many different forms. For the purposes of this study, leases will be grouped into three categories: ***true***, or ***tax-oriented*** leases, ***finance*** leases and ***leveraged*** leases. Each will be discussed briefly.

In the true or tax-oriented lease, the lessee typically produces or acquires the property, but conveys all his rights to the property to another individual or firm, including the tax benefits gained by owning the property. The new owner of the asset becomes the lessor and gives back some of the tax benefits by charging the lessee lower lease payments. The lessor is also responsible for all operations and maintenance costs associated with the asset. A true or tax-oriented lease can be simply defined as a ***"sell and lease back"*** agreement. This kind of lease agreement typically gives the lessee the opportunity to purchase the asset back at the end of the lease period. [Ref. 4: p. 30]

The Internal Revenue Service (IRS) and Courts issued a few guidelines for setting up a sale-leaseback contract.

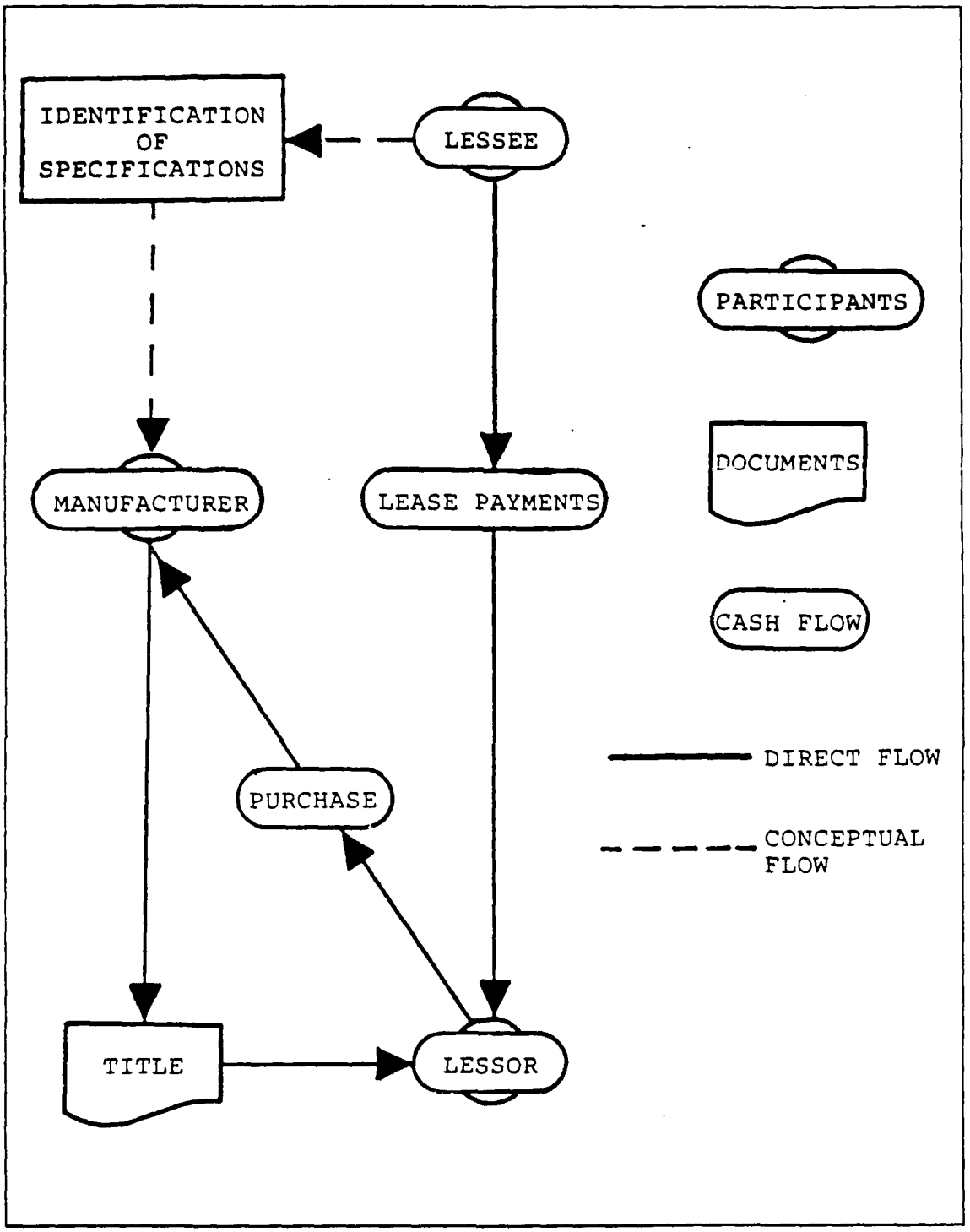

Figure 1. Diagram of a Simple lease.

Generally, a sale-leaseback is considered valid when:

- There is a valid business purpose to the transaction. However, the IRS goes even further in requiring that the transaction have a valid business purpose beyond any tax considerations, although some courts have declined to support that IRS requirement.
- The agreement, purchase options and terms should have resulted from an ***"arm's length"*** transaction between the parties. It should be set up as if the sale-leaseback had been arranged between outside and independent business parties.
- The characterization of the agreement should reflect economic reality.
- The seller should *not* retain substantially the same control over the property that he had before the sale.
- The agreement should be in writing and provide for a reasonable rent.
- A disqualifying equity in the property after the sale or lease could jeopardize the agreement. [Ref. 4: p. 30]

A finance lease is a lease which gives the lessee complete responsibility for an asset for most of its useful life. In other words, the lessee is responsible for managing the asset and for operations and maintenance costs, taxes and insurance. The lessor collects the lessee payment as a return on its initial investment. [Ref. 3: p. 7]

A finance lease has some important differences compared to a tax-oriented lease. In a finance lease, the lessee retains the rights and responsibilities of ownership, including recurring costs and system management. In addition, the lessee retains the tax benefits, so they are directly captured rather than indirectly realized through reduced lease payments. Finally, the finance lease may include a fixed purchase price at the end of the lease period for as little as 10 percent of the original cost of the asset [Ref. 4: p. 29]. The lessor is interested in the return on investment of the asset instead of the management of the asset.

The U.S. Government does this, in terms of MILSATCOM, by leasing the satellites in their geostationary orbit and then controlling the satellites. In this case, the lessor provides the launch, launching services and Tracking, Telemetry and Control services, but the government manages the system once

in orbit. The cost of these services is determined in the lease process [Ref. 2: p. 17].

The third type of lease is the leveraged lease. Compared to tax-oriented and finance leases, the leveraged lease can be considered more complex due to the participation of a third party. Simply, the leveraged lease is a lease in which the lessor can pay as little as 20 percent of the buying price and borrows the remainder of the price from a third party lender [Ref. 4: p. 29]. The lessor in this case is able to enjoy the full ownership tax benefits of the property, even though the third party loans money to the lessor to buy it. From an accountant's perspective, funding for a leveraged lease can be divided into two parts: ***debt*** and ***equity***. The lessor is the equity holder and remains the real owner of the property at the end of the lease term. The lessor also holds the tax benefits during the lease period. The third party is the debt holder and provides the debt financing for the asset. Third parties are typically banks or insurance companies. The debt holder receives most of the lease payments to cover interest and reduction of principal. The equity holder's return on investment is the residual lease payment remaining after servicing the debt. Figure 2 on page 9 [Ref. 2: p. 18] shows a leveraged lease flow diagram including the participants such as lessor, lessee, and the lender and the interactions among them.

4. Lease versus buy: Advantages and disadvantages

Leases have some practical advantages to many companies, especially small and start-up companies. In leasing, cash flow requirements can be easily predicted due to fixed monthly payments. Leases typically require no down payment and collateral, so that it reduces the ***up-front*** cash requirements. Another advantage of leasing is that it is more flexible than borrowing. Leases are considered operating expenses rather than capital expenses. Operating expenses are typically easier to authorize than capital expenses. This flexibility is attractive, even for the large companies. As Mr. Brooks WALKER Jr., Chairman of U.S. Leasing, states "In many big

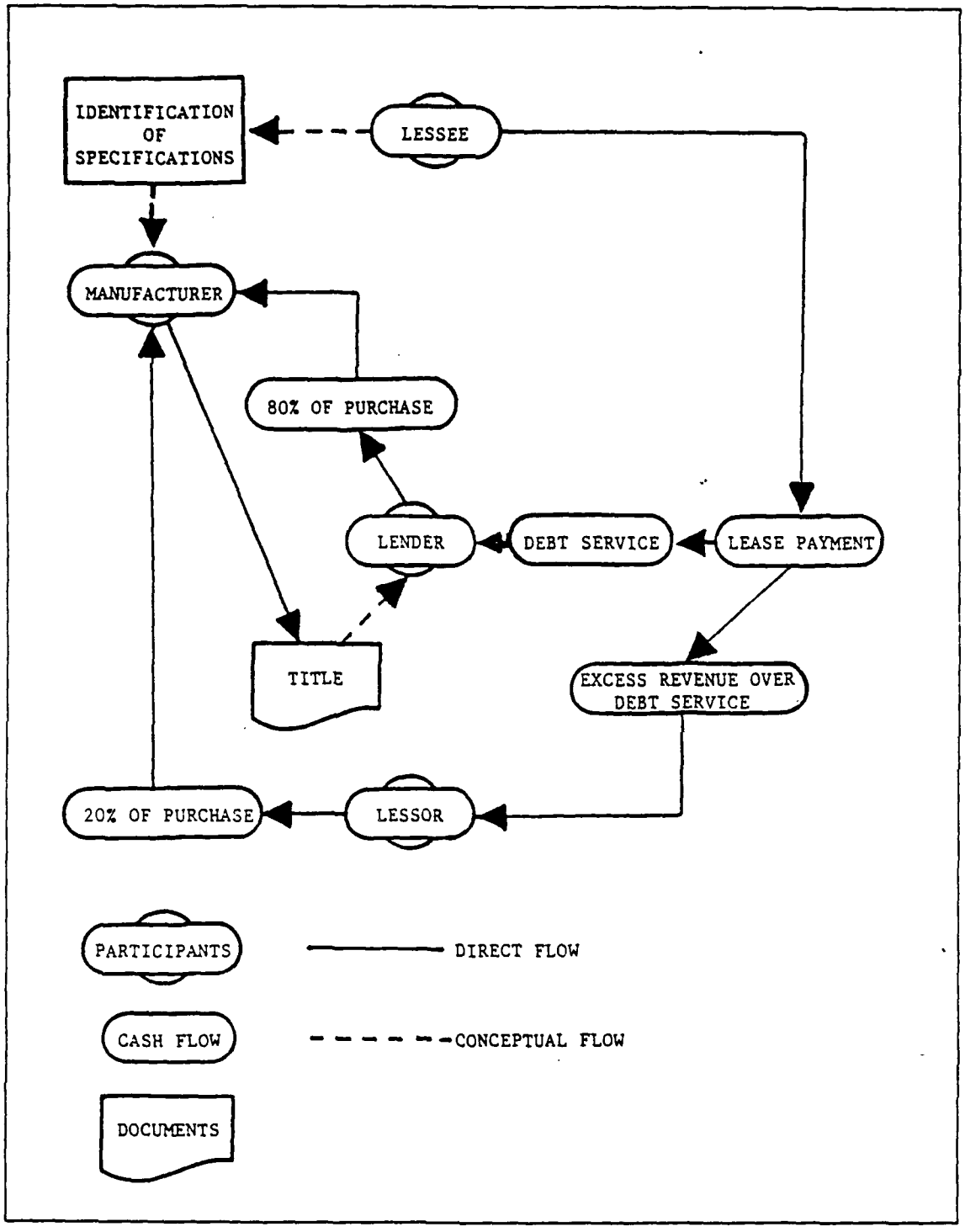

Figure 2. Diagram of a Simple Leveraged Lease.

companies and in government, the capital appropriations process is so complex that any change, especially in the middle of a year, is very difficult. Leasing is a way to get around that." [Ref. 5: p. 190]

The ability to shift tax benefits is another potential advantage that received a great deal of attention prior to 1986. Sometimes, small or start-up firms can *not* take advantage of the tax benefits, including accelerated depreciation and investment tax credit, associated with capital ownership. This creates an opportunity for a company that can utilize the tax benefits to purchase the asset and lease it to the interested firm. If the lessor passes on a portion of the tax benefits, the lease payments can be lower than the interest and amortization payments the lessee would face with ownership. The shift in the tax benefits can be to the advantage of both parties. [Ref. 6]

Leasing also has some disadvantages. Sometimes reduced lease payments might not be as valuable as the lost tax benefits, as often happens when a firm has a large tax liability. Another disadvantage is that the lessee loses ownership of the system. As a result the lessee sacrifices management control over system operation. Finally, lease agreements typically require that system operational specifications be specified well in advance of system operation. This reduces technical flexibility in responding to changes in demand or other conditions during the lease period.

B. PRIVATE SECTOR LEASING

Private sector leasing is not new. Although equipment leasing in the private sector started after World War II, its recent boom dates back to 1963. A 1963 decision by the Comptroller of the Currency allowed banks to lease personal property. Thus, banks gave leasing respectability and business increased and diversified from banks. New equipment having a value of $11 billion was leased in 1972, which accounted for almost 14 percent of all business investment in capital equipment. Statistics show that the volume of leases increased approximately 20 percent in that year. In the U.S., capital equipment worth more than $60 billion was leased to corporations, institutions

and governments in 1973. [Ref. 5: p. 136]. This value reached $150 billion in 1985 [Ref. 2: p. 20].

The Investment Tax Credit (ITC), which entered the U.S. tax code in 1962, encouraged firms without a tax liability to lease equipment. The ITC reduces a firm's tax liability by 10 percent of the value of capital investments made during the year. If a firm does *not* have a sufficient tax liability (as with small or start-up firms) the tax benefit is carried over to future years, reducing the value of the benefit. Thus, if a firm can *not* directly capture this benefit, there is an incentive to enter a tax-oriented lease and captured indirectly. In private sector leasing, the lessors originally assumed that Internal Revenue Service (IRS) would permit only 95 percent of the equipment included in the lease to qualify for the ITC. But according to IRS, all of the equipment qualifies.

Considering the shift in tax benefits, a company can often obtain an item under the tax oriented lease for a lease rate which is three or four percent lower than its long-term borrowing rate. Every tax-oriented lease must receive IRS approval before it becomes active. According to Vanderwichen, "A lease gets IRS approval if it provides that the equipment will have at least two years of its life expectancy remaining at the end of the lease; if the lessor assumes for financial-reporting purposes that it will have a residual value of at least 15 percent of its cost; and if the owner-lessor puts up at least 20 percent of the cost in equity funds [Ref. 5: p. 192]." The point of IRS approval is to clearly define the ownership of the property, making sure that the owner receives the tax benefits from the lease agreement.

Many companies can take advantage of ***tax-oriented*** leases. As mentioned earlier, tax-oriented leases are particularly attractive to firms showing losses on tax returns. However, profitable firms such as oil and mining companies can also make use of leasing if depletion allowances hold their effective tax rates below those of the lessors [Ref. 5: p. 192]. Several industrial corporations such as U.S. Steel, Eltra, Chrysler Financial, General Electric Credit, and PepsiCo are heavily involved in leasing. To a large extent, the

profitability of private sector leasing depends on the tax rates of both parties. [Ref. 5: p. 194]

C. PUBLIC SECTOR LEASING

Leasing and buying in the public sector are treated the same as in the private sector. However, there is one basic difference; the government does *not* pay taxes. Thus, reduced lease payments due to a shift in tax benefits do *not* actually save the government money. They simply shift the burden of the acquisition from the government agency leasing the asset to the general treasury. Tax benefits reduce corporate profits tax payments to the general treasury.

Several policy considerations, which are *not* applicable in private sector leasing, can also affect decisions in public sector leasing. For example, government policy encourages dependence on the private sector whenever possible. Leasing relies more heavily on private sector resources and management, reducing the use of public sector personnel and facilities. Risk taking considerations are different from private sector leasing, too. For example, in a military satellite communication (MILSATCOM) system, national security considerations frequently require that the system embody technology that advances the state of the art. Because of inherent technical uncertainties, which are *not* typically present in private sector systems, specialized contract arrangements are required that differ from the lease contracts used for private sector communication services. If the leased system is to be shared by public and private sector users, national security considerations make sharing the system difficult. A MILSATCOM system must have mobility (in order to communicate with small transportable, remote ground terminals), security (in order to be protected against anti-jam and encryption), and physical survivability (for protection against nuclear and laser weapons attacks). These requirements are unnecessary for private sector users. [Ref. 3: p. 8]

In past years, although a large number and variety of leases have been tried in the public sector, only a small number of them were successfully

employed. Almost all of the successful leases have involved shared systems. As a necessary result of this, the government evolved to the use of service leasing rather than equipment leasing. Shared leases are appropriate when, as in the case of telecommunications, government demand does *not* require leasing the entire system capacity. If the systems were *not* shared, the government would have unused capacity. For example, The U.S. government has *not* yet leased an entire satellite communications system.

MILSATCOM is an example of a shared system. The Department of Defense (DOD), Air Force Satellite Communication Facility (AFSCF), and National Aeronautics and Space Administration (NASA) are currently leasing communications services from common carriers such as RCA, AT&T (COMSTAR), Western Union (WESTAR), and INTELSAT. Some of the terminals are for government use and some are shared with other users.

Two other military satellite communications systems, GAPFILLER and LEASAT, are leased to provide UHF satellite communications services to mobile platforms. Comsat General Corporation first bought the GAPFILLER satellites from Hughes Aircraft and then leased them to the U.S. Navy. In LEASAT, satellites were bought by a group of lessors from Hughes Aircraft. The satellites were then leased to Hughes Communications Service and finally, in turn, Hughes Communication Service leased the communications service to the U.S. Navy. The LEASAT leasing agreement is detailed in Chapter IV.

As mentioned above, one important factor in a shared system is whether or *not* the hardware or service can be shared among the military and civilian users. For example, can agreement be reached on location and control of the satellite to satisfy all parties? In such a leasing contract, priorities have to be set up to guarantee that the primary government functions are met by the system. [Ref. 7: p. 5]

III. FACTORS CONSIDERED IN A LEASE VERSUS BUY ANALYSIS

There are several important factors which should be taken into consideration in a lease versus buy decision. These are ***technical*** aspects related to technical requirements and ***management*** aspects related to cost and decision-making responsibilities associated with managerial control. The technical and the management areas are interrelated, making it difficult to separate one from the other. Finally, there are ***financial*** aspects related to both funding and cost factors, including the tax implications taken into consideration in lease versus buy decisions.

A. TECHNICAL ASPECTS

Technical aspects in lease versus buy decisions for both the private sector and government sector are an important matter which require precise work and good planning. Capital assets have life spans that extend over several years. This is reflected in the duration of most leasing contracts and is even more evident when the asset is purchased. That's why both government and private sectors have to know their objectives and their requirements. This is complicated because technology and the requirements change over time.

The technical considerations in a lease versus buy analysis for a satellite communications system involve the technical requirements and the risks related to them. For the lease situation, satellite communication system requirements are stated in terms of ***service*** and ***performance***. According to the lease strategy, the design is ***"frozen"*** at the time of contract award in order to have the program run smoothly [Ref. 2: p. 27]. Because of the inflexible specifications, the system contractor may get some important savings in optimizing design and construction. This may occur without affecting the government contract because performance rather than design is considered in the satellite specifications. However, this places most of the risk

of technical uncertainty on the lessor, rather than the government. This makes leasing less appropriate when technical uncertainties are significant.

In the buy alternative, requirements are stated in terms of ***design*** specifications rather than ***performance*** specifications. There are two aspects to flexibility, ***construction*** flexibilities from the contractor's point of view and ***management*** flexibilities from the buyer's point of view. Design specifications are generally more flexible from the buyer's perspective. The contractor has to design the system to meet whatever requirements are set by the buyer. With a lease, performance specifications are typically set early in the design process. This gives the contractor construction flexibility in designing the system to meet the performance specifications, but it limits the buyer's management flexibility in changing those specifications. On the other hand, in the buy option, design specifications limit the contractor's construction flexibility. However, design specifications have flexibility so that they may be changed to accommodate changing requirements as the technology changes. This causes a series of re-approval phases. As a result, high costs and delayed programs are more prevalent when the government buys a system than when the system is leased. Furthermore, the government bears the risk of technical uncertainty in a purchased system. [Ref. 2: p. 28]

The technical evaluation in lease versus buy decisions must balance the relative ***strengths*** and ***weaknesses*** of the purchase and the lease alternatives. Leases provide the contractor with more flexibility in designing the system but reduce the lessee's flexibility because the design is frozen. However design specifications generally result in a more smoothly running program with fewer delays. In the buy alternative, technical requirements are more flexible but this can result in more delays and higher costs. The appropriate balance will depend on the uncertainty of future requirements and technical improvements, and on the level of technical uncertainty. [Ref. 2: p. 28]

The technical aspects of the lease/buy decisions are listed in Table 1 on page 16. [Ref. 7: p. E2]

B. MANAGERIAL ASPECTS OF THE LEASE VERSUS BUY EVALUATION

Managerial aspects are also important and can *not* be separated from financial and technical aspects. Managerial aspects during system planning and construction are affected by the lease versus buy decision, because a lease is based on ***performance*** specifications rather than ***design*** specifications. A lease requires less administrative and management effort because it doesn't require review in the Planning, Programming and Budgeting System (PPBS). Thus, management overhead for the government will be lower, both in the administrative and planning phases of the program. The manufacturer and lessor are responsible for management to meet the performance requirements once they are determined and agreed on in a contract. This lessening of management overhead corresponds to the inflexibility of the design. [Ref. 2: p. 29]

Table 1. COMPARISON OF LEASE/BUY (TECHNICAL)

Lease	*Buy*
Performance specifications written in terms of service.	Specifications written in terms of equipment design or performance characteristics.
Contractor may be able to optimize design to provide service without detailed justifications/reviews with government.	Design may be changed, by contractor, but may involve many layers of review and approval.
Fixed price specifications are frozen at time of contract award making for a smoother running program with less chance for delay. However, freezing design prohibits government from changing the system to meet changes in requirements.	Design may be changed to meet changes in requirements at extra time and cost. Program delays may require management attention.

Other management considerations are observed in contract negotiations which characterize both leasing contracts and purchase contracts. These management considerations concern: the type of contract (fixed price, cost

plus fixed fee, or some combination of the two); the payment plan; and the period of the lease contract. Another important management issue is to define satisfactory and unsatisfactory performance of the system. [Ref. 2: p. 30]

Managerial aspects are simply treated as the ***trade-off*** between managerial control and the costs related to such control. In a lease option, governments have lower management costs since the number of personnel assigned is small and the administrative costs related to top management levels are low. In return, however, the government sacrifices management control. In the case of purchase, managerial and administrative costs are higher than in lease option, but the government has greater management control. The proper balance depends on the trade-off between managerial costs and the importance of managerial control. [Ref. 2: p. 30]

The management aspects of the lease/buy decisions are listed in Table 2. [Ref. 7: p. E4]

Table 2. COMPARISON OF LEASE/BUY (MANAGERIAL)

Lease	*Buy*
Possible reduction in management effort by government personnel.	Usually higher involvement by government management personnel because of added acquisition responsibilities.
government has little management control over the system development.	government has full management control over the system development.

C. FINANCIAL ASPECTS OF THE LEASE VERSUS BUY EVALUATION

The financial aspects of the lease versus buy evaluation are more complicated. There are basically three factors included in the financial category, cash flow factors, financial risks, and tax inducements. To properly integrate these factors, Federal agencies should make a detailed economic analysis before making their lease versus buy decision for a specific good or service [Ref. 8: p. 5].

1. Cash Flow Factors

In the lease option, costs will be spread over the lifetime of the lease. Operations and maintenance funds are used to make the lease payments, which take place concurrently with the in-orbit service period. Leasing has lower up-front costs but higher annual operating cost, because development, procurement, launch, and testing are amortized in the lease payments rather than incurred up-front. [Ref. 2: p. 31]

However, in the buy option, procurement moneys must be approved and budgeted into the yearly budget process. In this option large upfront expenditures are required during the Research and Development (R&D), procurement, launch, and testing phases. Since owning a telecommunications system is a big investment, this requires careful managerial oversight and a detailed budgeting process. [Ref. 2: p. 32]

2. Financial Risks

There are financial risks as well as technical risks. Technical risks are a matter of the design and the production process of the system. Financial risk represents potential dollars required to develop and purchase a particular system. *"The higher the technical risk, the greater the financial risk* [Ref. 2: p. 32]." Thus, these two risks can *not* be separated from one another.

There are several aspects involved in supporting commercial satellites in their geostationary orbits. Planners should consider these issues and their financial risks, including pricing policies, transportation system choice, insurance, satellite confirmation, technology, transponder configuration, reliability, sparing and life span of the satellites. The manner in which these aspects are specified in the lease contract will determine whether the lessee or lessor assumes the associated financial risks. Assessing the financial impacts associated with alternative options will help determine the best alternative. Incremental annual profit, cash flow, return on investment and risk, which are evaluated in terms of variability of performance criteria, are the financial criteria used to rank alternative specifications. [Ref. 9: p. 32] In order

to evaluate the financial impacts of these alternative decisions on communications satellite business enterprises, a general financial planning model has been developed. This model considers a variety of factors ranging from the number of spare transponders to the transportation system [Ref. 9: p. 34].

The lease and the purchase alternatives generally face a two step cost comparison process. In the first step, all cost categories related to each alternative during its economic life must be identified. The second step is the process of estimating the quantity of each cost category and the timing for each category under each alternative. After these two steps are determined for the lease and buy options over their functional lives, the annual costs should be changed into their present values to incorporate the time value of money. After this process, buy and lease alternatives are compared to determine the alternative with the lowest present-value costs. [Ref. 8: p. 5]

The time value of the money in any lease versus buy analysis is one of the major factors and should be considered carefully [Ref. 8: p. 7]. A main difference between the lease and the buy alternatives of satellite communications system lies in the timing of the expenditures. Large expenditures are required in the early years to capitalize the development and the manufacturing process for a buy option. After the system becomes operational, the expenditures typically decrease to a relatively steady level. In the lease option though, the lessee has lower expenditures in the early years, but higher annual expenditures are required after the system becomes operational. As an example, the 1975 estimates of NASA show the differences in timing of Tracking and Data Relay Satellite System (TDRSS) expenditures in both buy and lease alternatives in Figure 3 on page 20.[1] [Ref. 8: p. 15]

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1 Data are from NASA's January 1975 lease-versus-purchase analysis which includes costs in constant 1974 dollars but does not reflect reduced costs due to Federal tax recoveries.

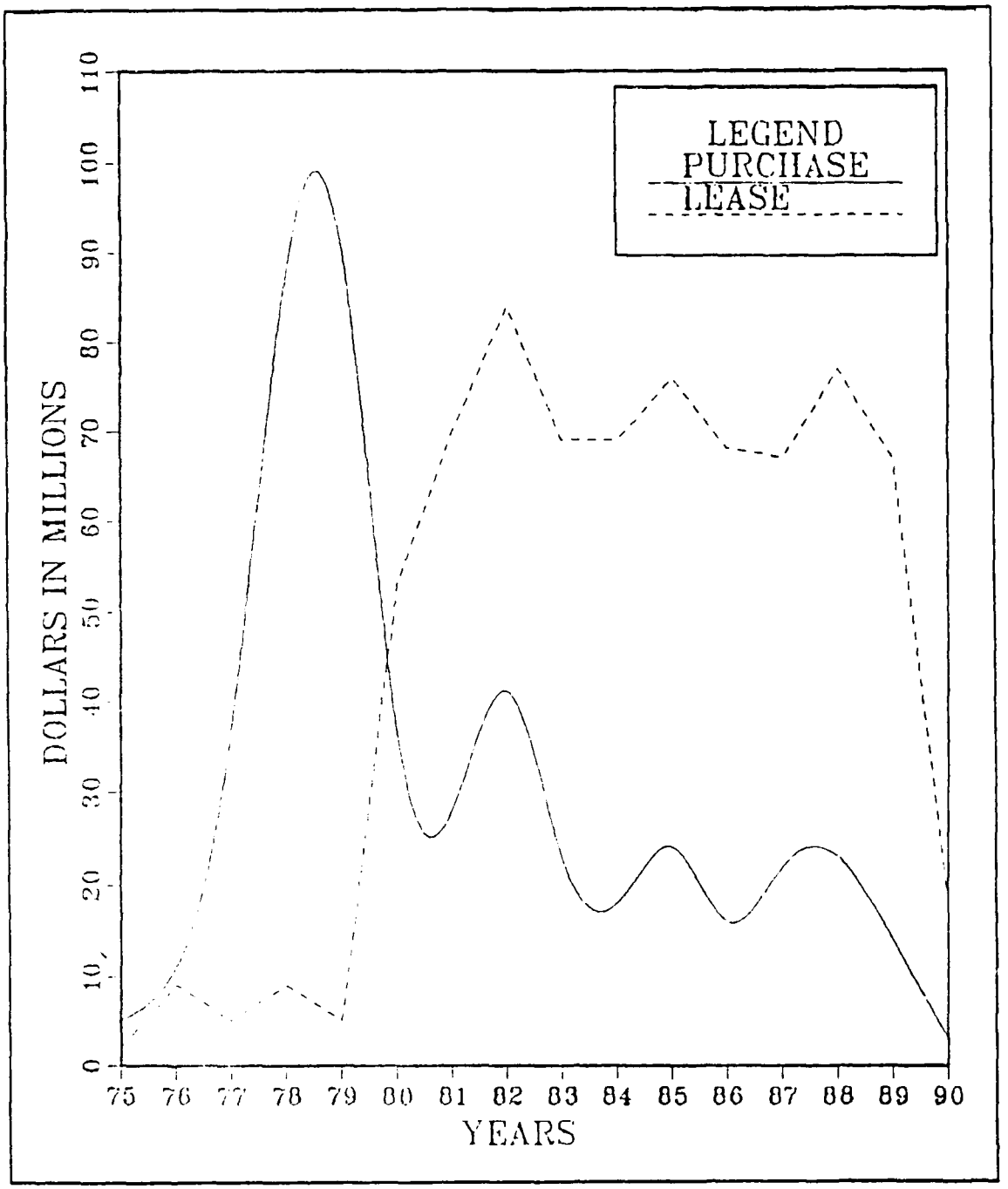

Figure 3. Timing of Government Expenditures for TDRSS Service Via a Purchase or a Lease Method

3. Tax Inducement

What is one of the main factors behind attracting commercial entities into the leasing world? The simple three letter word ***tax*** gives an important answer to this question. Tax implications make leasing a satellite communications system to the government particularly attractive to commercial enterprises. The leveraged lease is designed to shift tax benefits in order to provide the lessor a sufficient rate of return while providing the government with lease costs below the normal financing costs [Ref. 2: p. 33].

Prior to the tax law changes in 1986, owning a satellite communications system brought tax benefits including depreciation, or Accelerated Cost Recovery (ACR), and the Investment Tax Credit (ITC). Depreciation spreads the cost of the asset over its useful life time, when the asset is used to generate income over several years. Property is considered depreciable if it is used for business or expected to generate income. The depreciation period is a matter of wear and tear, exhaustion, or obsolescence. The total depreciation deduction is generally limited to the cost of property minus the estimated salvage value. Since useful life of a satellite communications systems is usually considered 8 years, the annual depreciation deduction is simply the total allowable deduction spread over this eight-year period.

The Accelerated Cost Recovery System (ACRS) took effect in 1981. ACRS eliminated salvage value in calculating total depreciation basis and accelerated the depreciation process by reducing the system life used for tax purposes, shifting the bulk of the annual depreciation allowance to earlier years of the system life. ACRS is very complex but provides an increased investment motivation for capital and economic enlargement. [Ref. 10: p. 25]

The second benefit of owning a satellite communications system was the ITC. ITC reduced the amount of taxes required of a business purchasing capital assets. The lessor could claim 10 percent of new capital investment as a credit against income tax liabilities in the current year. The ITC was a tax credit as opposed to a deduction from taxable income. [Ref. 10: p. 25]

Because a government agency does *not* pay taxes, government agencies did *not* capture the tax-related benefits of owning a capital asset. This created the opportunity to use a tax-oriented lease to pass the tax benefits to a private sector business in return for reduced lease payments. Thus, tax benefits appeared to reduce lease costs relative to purchase costs.

Phillips, however, contends that leases may actually be more expensive than purchases, ignoring the tax implications.

> In general, a long term leasing program that provides for leasing an asset for its useful life will be more expensive than purchasing the asset because a third party --the lessor-- is involved; whereas, in a procurement arrangement, only the purchaser and the manufacturer are involved. Thus, it would be expected that the third party will require a return on his investment and this will be passed on to the lessee as an added expense. If the lessor's required rate of return exceeds the Government's discount rate, the yield on Government securities, leasing will be more expensive than purchasing. The reason is that a lessor would expect to earn a higher rate of return on his investment than he could earn by investing in Government securities and his added expense is passed on to the lessee. [Ref. 2: p. 37]

Thus, a lease will appear less expensive than purchasing the system if the reduced government management costs and shared tax benefits exceed the added profit required by the lessor. Thus, It is obvious that the financial attractiveness of the lease and the purchase options are considerably affected by the tax rate and timing of Federal corporate tax payments. [Ref. 8: p. 15] However, Phillips [Ref. 2] and Block [Ref. 6] point out this comparison is flawed. The shift in tax benefits do *not* actually save the government money. It simply shifts the burden from the leasing agency to the general treasury. Thus, from an overall government view point, tax benefits should be ignored in lease versus buy analysis.

In brief, leasing satellite communications systems to government agencies appears attractive because leases allow the agency to spread the cost of the system over several periods. The agencies can also use operational and maintenance funds instead of procurement funds. Government agencies put more managerial effort into purchases than into

leases. Finally, leasing appears to cost less to the leasing agency because some of the cost is shifted from agency's budget to the general treasury as reduced tax revenue. [Ref. 2: p. 38]

The financial aspects of the lease/buy decisions are listed in Table 3 on page 24. [Ref. 7: p. E3]

D. CURRENT TAX REGULATIONS AFFECTING U.S. SATELLITE COMMUNICATIONS

Prior to 1984, depreciation or ACR and ITC were the tax benefits associated with ownership of the property. However, these benefits began to decrease after the Deficit Reduction Act (DRA) of 1984 and were virtually eliminated in the Tax Reform Act of 1986. These regulations affected the U.S. satellite communications sector within the U.S. as well as abroad.

The 1984 tax bill eliminated the ITC and ACRS benefits if the capital asset was used by a ***tax-exempt entity***. A tax exempt entity was defined to include schools, churches and charitable organizations, as well as foreign persons or organizations (entities that did *not* pay U.S taxes). Under DRA, if a satellite owner leased the satellite or some of its transponders to any non-tax paying entity, it lost the accelerated depreciation and investment tax credit on the portion of property leased to the non-tax paying entity. The fear of losing the tax benefits forced satellite owners to consider leaving their satellites idle rather than losing these benefits. [Ref. 10: p. 24]

The 1986 tax reform eliminated the 10 percent ITC for all business investment and reduced the depreciation allowance [Ref. 11: p. 25]. The ITC turned out to be the biggest loss to the telecommunications industry.

Table 3. COMPARISON OF LEASE/BUY (FINANCIAL)

Lease	*Buy*
Generally uniform cash flow of O&M funds over lifetime of system.	Major outlay of procurement funds early in program and over relatively short term.
Lessor may be able to buy satellites at a lower cost than government due to less review and fewer unique specifications and tests.	Government procurement costs tend to be higher due to management reviews, tight specifications, and extensive testing.
Total cost is generally higher due to insurance, cost of capital, and return on investment to lessor.	Government has no insurance program nor return on investment considerations. There is no actual cost of capital but is imputed in cost analysis.
Investment tax credits and deferred taxes tend to lower effective interest rate on loans.	There are no investment tax credits for bought system. Deferred taxes are not an issue.
Total payment is in the form of in-orbit performance incentives. Thus, the lessor is gambling 100% of his income on product performance.	Government typically dedicates 10-15% to in-orbit performance incentives. Thus, the vendor is gambling only 10-15% of his income on product performance.
Capital financing may not be possible without government guarantees.	Capital financing is not required.
Termination liability would typically be structured to guarantee the lessor some reasonable return for his efforts and loss of potential profit.	Termination liability limited to sunken development and production costs.
Lessor assumes financial risk for successful performance. However, degree may be limited or minimized through negotiation or financing arrangements that shift more risk to the lessee.	Government assumes financial risk for successful performance.

Congress included some exceptions for assets being procured on January 1, 1986, the date the ITC expired. It gave companies an opportunity to use the credit even on property put in service after December 31, 1985, as long as the property was contracted for on that date. According to this tax reform, five-year property and seven-to 20-year property could qualify for ITC as long as they were put in service before January 1, 1987 and 1989 respectively. [Ref. 11: p. 24]

Thus, lease versus buy decisions made after 1986 should reflect the new tax laws. One interesting question concerns the expected impact that these changes in tax laws will have on government lease versus buy decisions. Presumably, leasing will appear to be a less attractive option. Of course, the change in tax laws will *not* affect the actual cost of government leases, only the portion of the lease cost shifted from the leasing agency to the general treasury. Government agencies will now be forced to consider the actual cost and benefits of the leasing option, *not* the perceived tax benefits.

IV. ANALYSES OF LEASAT AND UHF FOLLOW-ON

A. WHAT IS LEASAT?

The origin of satellite communications dates back more than 30 years. It started with a scientific article written by a British Scientist named Arthur C. CLARKE [Ref. 12: P. 6]. The Navy established the first operational satellite communications system in 1959, using the moon. [Ref. 12: p. 7]

The Navy's first leased communications system was called GAPFILLER, which received service from the Maritime Satellite system (MARISAT). Three MARISAT satellites were procured and managed by the Commercial Satellites (COMSAT) General Corporation. These satellites were launched in 1976 and placed over the Atlantic, Pacific, and Indian oceans. The Navy leased the Ultra High Frequency (UHF) transponder on each of the three MARISAT satellites in order to establish an independent Navy communications capability. The Navy's leased portions of MARISAT was named GAPFILLER in order to differentiate between MARISAT and Navy management and control. It was leased to fill the gap during the transition from the first generation satellite system to the follow-on Fleet Satellite communications (FLTSATCOM) system.

FLTSATCOM was the first operational communications system designed for Navy's use only. It is an information exchange system that uses the satellites as communications relays. FLTSATCOM originally consisted of ten satellites but was later reduced to five. The first one was launched in 1978. Compared to GAPFILLER, by design, it was heavier and larger.

The estimated cost of the FLTSATCOM was $509 million, or an average of $100 million per satellite. The Navy purchased these satellites which were very expensive compared to the most modern commercial communications satellites. Commercial systems at the time cost $40.2 million per satellite, including launch costs. According to these costs estimates, the FLTSATCOM system cost 249 percent more than the commercial communications satellites.

As a result of this difference, alternatives to purchasing a Navy system were explored. In the FY 1978 Appropriations Act, Congress directed the Navy to lease communications satellite service instead of purchasing the satellites for the fleet use. Following this mandate, the U.S. Navy contracted to lease its third operational system, Leased Satellite (LEASAT), which is a follow on to MARISAT or GAPFILLER. [Ref. 13: p. 624]

Thus, in 1977 Congress directed that a leasing program be utilized as an alternative to purchasing the complete FLTSATCOM system. The Secretary of Defense designated the Navy as the executive service for this project and assigned the Navy to prepare a request for proposal to be released in calender year 1978. After going over different industry proposals, Hughes Communications Services, a division of Hughes Aircraft Company, was selected as the prime contractor for LEASAT. [Ref. 12: p. 35]

The LEASAT system provides worldwide satellite communications services to land mobile, airborne, shipborne, and fixed stations of the U.S. Navy, Marine Corps, Army, and the Air Force as well as the joint chiefs and unified commanders with a five-year service period. The Navy is the largest user of LEASAT.

B. GENERAL LEASE/BUY METHODOLOGY

The General Accounting Office (GAO) described a four step general lease/purchase decision model when it addressed the overall methodology used by the NASA in making its lease/buy comparison for the Tracking and Data Relay Satellite System (TDRSS) [Ref. 8: p. 5-6]. Basically, the first step deals with the cost categories related to each alternative during the system's economic life. The number of cost categories in this comparison can be broad depending upon the complexity of the system.

The second step deals with estimating the magnitude of each cost category and the time in which the cost will be incurred under each alternative. To provide accurate estimates of the net cost implications of each of the two alternatives, and their corresponding cash flows, it is important to estimate

both the magnitude and timing of these costs. In both the purchase and lease alternative, costs where the amount and timing are the same are *not* important to consider since there is no economic difference between them.

The third step emphasizes the time value of money. Once the costs for the buy and the lease options have been determined over the useful life of the system being considered, then the annual cost must be converted into their present values considering the time value money.

Finally, the fourth step is a comparison of both alternatives. In this case, the present value of both buy and lease costs will be compared and whichever has the lower present value of costs is considered the more economically attractive.

Figure 4 on page 29 [Ref. 2: p. 41] shows the information suggested by GAO for lease/buy comparisons.

C. THE NAVY'S MILSATCOM LEASE/BUY MODEL

The Navy has used a similar model to evaluate its purchase versus lease decision for satellite communications systems. This model was written for an IBM compatible Personal Computer (PC) with Lotus 1-2-3 software. Dr. Patricia M. Dinneen prepared a model program to evaluate MILSATCOM lease versus purchase choices quantitatively, while working for RAND Corporation. [Ref. 2: p. 40]

This model has the following objective:

> Provide a general, flexible parametric model to assist government and corporate decision makers in determining when to lease rather than buy. The model can be used by the Government to determine conditions under which leasing is less costly than buying and by the private firm to determine when leasing is more profitable than selling. [Ref. 2: p. 41]

Figure 5 on page 30 [Ref. 2: p. 42] shows the Navy's decision model.

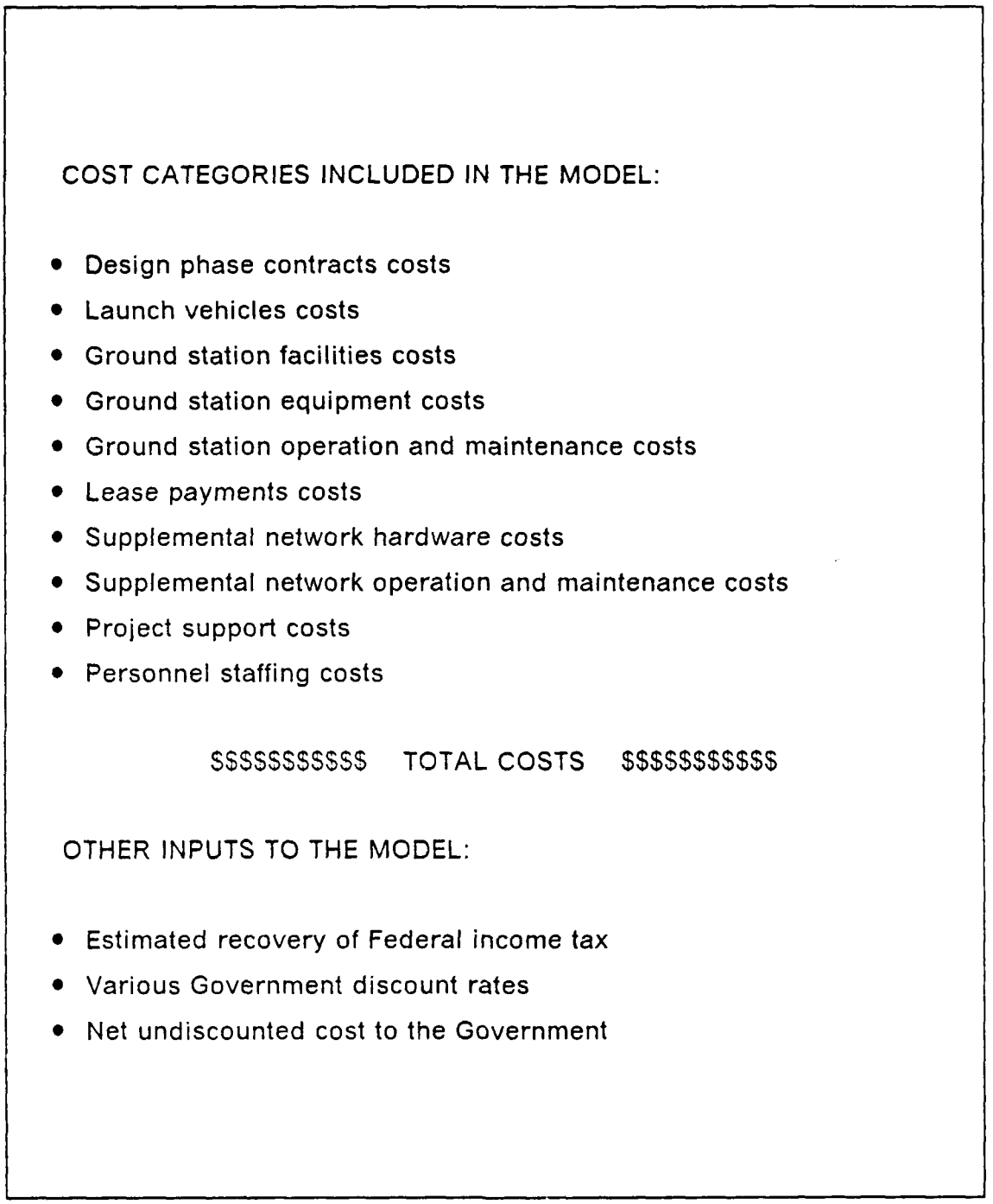

Figure 4. The General GAO Lease Versus Buy Model

COST CATEGORIES INCLUDED IN THE MODEL:

- Research, development, test and evaluation costs
- Spacecraft cost
- Launch vehicle cost
- Ground equipment costs = cost of ground station control facilities
- Seller's/Lessor's other costs:
  - Insurance
  - General administration expenses
  - Tracking, Telemetry and control (TT&C) costs
- Seller's profit rate and price in the case of a buy

$$$$$$$$$$$$ TOTAL COSTS $$$$$$$$$$$$

OTHER INPUTS OF THE MODEL:

- Corporate tax rate
- Government tax rate
- In the case of a buy:
  - Seller's discount rate
  - Annual profile of costs and payments
- In the case of a lease:
  - Interest rate on lessor's loan
  - Investment Tax Credit
  - Depreciation method utilized
  - Lessor's discount rate
  - Annual profile of costs and payments
- Period over which lessor pays back loan

Figure 5. The Navy's Lease/buy Model

The specific lease and purchase outputs of the Navy's model are as follows:

Lease outputs of Navy's model;

- Lease payment/target -- the amount of annual lease payments, calculated on the basis of lessor's costs, discount rate and the number of lease years.
- Annual loan payment -- the amount of annual loan payments, calculated on the basis of the lessor's costs, interest rate and number of loan years.
- Lease payments -- the schedule and amount of annual lease payments.
- Lessor's costs -- the schedule and amount of annual administrative costs.
- Lessor's loan payments -- the schedule and amount of annual loan payments spread over the designated number of loan years. [Ref. 2: p. 44]

Purchase outputs of Navy's model;

- Sellers progress payments -- the schedule and amount of annual progress payments.
- Seller's costs -- the schedule and amount of annual costs.
- Seller's taxes -- the schedule and amount of annual taxes.
- Seller's cash flow -- the schedule and amount of annual cash flows.
- Seller's PDV $ -- the schedule and amount of annual, present discounted value of seller's cash flow, using the seller's discount rate.
- Government cash flow -- the schedule and amount of annual cash flow.
- Government's PDV $ -- the schedule and amount of annual present discounted value of Government's cash flow, using the Government's discount rate.
- Agency's PDV $ -- the schedule and amount of annual present discounted value of the Agency's cash flow. This amount will differ from the Government's PDV $ because the seller's taxes are excluded.
- Seller's IRR -- the Internal Rate of Return, defined as that discount rate such that the present value of the seller's cash flow is zero. [Ref. 2: p. 43]

Comparing these two models implies that there is more flexibility in defining the information used in the Navy's model than in GAO's model. This flexibility enables the Navy's model to account more accurately for the

decision variables. However, the cost inputs in both models are similar. Due to the differences in the information used, the outputs of the two models will vary.

Furthermore, both models incorporate the tax benefits captured by the lessor in estimating expected lease payments. In GAO model, NASA deducted the estimated corporate income taxes from the estimated lease/purchase costs. These estimated Federal income taxes were made up of two elements. The first one was the income taxes paid by contractors, and the second one was income taxes resulting from ***interest*** paid by contractors to lending corporations. In addition to these tax deductions, NASA also wrote off the income taxes that would be paid by the prime contractor and subcontractors from its estimated cost of purchase [Ref. 8: p. 15]. In the Navy's model, government and corporate tax rates were important to the Navy's lease/buy analysis. In addition to these tax considerations, ITC was considered as another important factor in the event of a lease.

D. LEASAT CONTRACT WITH HUGHES

The leasing of this satellite system was conceptually different from the Navy's leasing of Gapfiller Satellite (GAPSAT). In the GAPSAT case, the Navy leased the communications services from the communication Satellite Corporation (COMSAT) which in turn bought the satellites from the subcontractor, Hughes Aircraft Company. In the LEASAT case, the Navy leased the equipment from Hughes Communication service. The LEASAT Satellites will be purchased from Hughes Aircraft by a group of lessors. The lessors will lease the satellites to Hughes Communications Service, who will, in turn, lease the communication service to the U.S. Navy. This is a leveraged leasing arrangement that enabled the Navy to share the tax advantages.

The noticeable points in this contract are as follows:

- No increase in price for the originally contracted services ($335 million for five years of service from four orbital positions).

- A firm fixed price option to extend satellite service for two additional years with an additional option to buy the satellite at the end of this seven-year lease period.
- Navy flexibility in dates of service commencement.
- A revised payment schedule that would provide Hughes with some payments in advance of the commencement of services, subject to the availability of appropriations for this purpose. [Ref. 14: p. 7-8]

With this contract, another important issue, involved the Navy's requirements when the lease period expired. The contract included a five-year lease plus a two-year option for each satellite and a purchase option after the seven-year service period. According to Rear Admiral Richard C. MACKE, Naval Space Commander, "Purchase of the satellites will be an issue in the next few years as it involves a substantial amount of money [Ref. 15: p. 12]." Thus, the Navy obtained the option to expand in-orbit service from five to six or seven years. The Navy also obtained a purchase option for each satellite after seven years of service. [Ref. 14: p. 12]

According to section three in the LEASAT contract between the Navy and Hughes Communication Services Inc., (see appendix C) the Navy agreed to pay $67 million at the time communication services started. Later payments were scheduled according to the following funding profile:

Fiscal year	
1983	$55
1984	$55
1985	$40
1986	$40
1987	$40
1988	$38

If the Navy had decided to exercise the lease and purchase options, Hughes would have received $20 million for each additional year of service and $15 million for each satellite purchased. If the Navy had purchased the

satellites, Hughes would have provided tracking, telemetry and control services throughout the remaining life of the satellites. The Navy would have paid $5.4 million per year for these services. [ref. 14: p. 12-13] Other details of this contract are included in Appendix C. The actual contract outcomes are now discussed.

1. Navy's Position in LEASAT

As stated before, this program was originally mandated by Congress. The intent was to acquire additional capacity at a lower cost than projected for FLTSATCOM program, considering the comparative cost estimates of FLTSATCOM and commercial satellites. As a trade-off for lower costs, the LEASAT satellites were less capable than the FLTSATCOM satellites, particularly in survivability (nuclear hardening). The implication was that the leased system provided essential communications capacity and meet minimum technical standards (Appendix B shows the service differences between FLTSATCOM and LEASAT) at a much lower cost.

DOD selected the Navy as its executive agent in the LEASAT program, in part because the Navy had the greatest share of capacity among all users. Given this responsibility, the Navy approached the lease contract carefully, drawing heavily on NASA experience in leasing the TDRSS system. According to the Navy, cost effectiveness and leasing enough capacity to meet its needs were the most important factors in their leasing decision. [Ref. 13]

The lease has proven to be an economical and efficient means for providing UHF satellite communications connectivity [Ref. 14: p. 3]. Navy officials are pleased with the result of leasing the LEASAT satellites, but they do *not* expect that they will be able to repeat the LEASAT arrangement. As Macke said,

> That leased contract was a good deal, it was smart. We will never get another one like it. Hughes took a bath. The insurance companies took a bath. We got a good deal. There is still extensive yearly negotiations on how much we are going to pay for it. You will never see it again because nobody is going to sign up to the kind of deal Hughes signed up to. [Ref. 15: p.51]

There are several reasons for Navy to lease a communications system. First, the Navy can obtain services for a fixed-price. This minimizes the risk of cost overruns. Second, the Navy can establish services while avoiding a major initial capital investment. Third, leases minimize the financial risk of launch or in-orbit satellite failures. Finally, the Navy benefits from the engineering and operating experience of the private sector in developing reliable and economic satellite communications services using proven technologies. [Ref. 16: p. 134]

In the case of Navy's LEASAT program, these reasons indicated a lease would be beneficial for the Navy. As stated before, the Navy benefited from the fixed-price policy, avoided an initial large capital investment, and had no responsibility for the financial risk of launch and satellites failures in their orbits. The Navy also benefited from economical and technological standpoint by leasing these satellites.

E. UHF FOLLOW-ON

The Naval Space Command has determined that one of its highest priorities is to acquire a new generation of UHF communications satellites to replace the FLTSATCOM and LEASAT communications satellites in the 1990s. These current communications systems are being forced to last almost twice their seven-year design lives. The Navy Space Command has put a high priority on a UHF follow-on system in order to prevent any discontinuity in its global communications activity. The UHF Follow-on satellites will be designed to have a minimum 10 year service life with an average 14 year life expectancy. The first satellite of this program is scheduled for launch in 1992 [Ref. 15: p. 46]. For this project, General Electric, TRW, and Hughes Aircraft competed for the UHF Follow-on (UFO) contract. The Hughes Aircraft Corporation won this competition. The contract will be managed by the Space and Naval Warfare Systems Command (SPAWAR). Estimated costs for the Navy exceed $1 billion.

Initially, Hughes will design one satellite, the newest line of its spacecraft series. After this satellite becomes operational, it will provide communication services to ships at sea and other fixed and mobile stations widely scattered around the world. [Ref. 17: p. 1]

Hughes will take the old Navy systems into consideration making the new system operationally compatible with the older terminals still in use. The new system will also employ the same frequency spectrum as the current system, with a larger number of transmitters providing more communications capacity. [Ref. 17: p. 1]

1. Considerations Compared to LEASAT

In the UHF Follow-on program, it appears that technical requirements played a more important role than they had in the LEASAT program. Thus, the Navy had to look at the factors in the lease/buy decision differently than in its earlier decision. In particular, flexibility and technical uncertainty became much more critical factors. Because purchasing becomes more attractive as flexibility and technical uncertainty increase, this factor favored a purchase rather than lease decision for the UHF follow-on satellites.

Another important issue was the tax law changes in 1986. As stated earlier, DOD lost its perceived tax benefits on leasing an asset as a result of these tax regulations. For a system expected to cost the Navy in excess of $1 billion plus launch costs, these tax benefits could be substantial. Thus, both technical needs of the Navy and the change in tax laws favored a purchase rather than lease decision for UHF follow-on satellites.

2. Framework for Lease versus Buy Cost Analysis

There are several issues that need to be resolved before conducting a lease versus buy cost analysis for the UHF Follow-on program. These issues include system lifetime, insurance costs, financing and launch costs. It is important to ensure that each of these factors is treated equivalently in both the lease and purchase options or the analysis might be biased.

- **Issues**
  - **Lifetime**

Satellite lifetime introduces a complication into the lease versus buy cost analysis. As stated earlier, the UHF Follow-on satellites are designed for a ten year service life and a maximum 14 year design life. This four year difference brings up an important issue. In a lease, an asset must have at least 20 percent of its design life remaining at the end of the lease period for a contractor to qualify for special lease tax treatment. Thus, 10 years were considered the maximum lease period. In the purchase case, the Navy receives an extra four years of communications service. In the lease/purchase cost analysis, both options must have comparable lifetimes. There are two possible corrections. First, a ten year life can be used for both options. To make the systems comparable, in this case, it is necessary to estimate the residual value of the satellites after 10 years and deduct this salvage value from the cost of the purchased system. The second correction would be to compute the lease cost as if the lease period was 14 years. Both corrections were considered in the UHF Follow-on program. [Ref. 18]

  - **Insurance costs**

Insurance costs have become an important consideration in light of recent launch experience. In the lease case (or in a purchase if the system is purchased in orbit), it is the responsibility of the contractor to insure both the launch and on orbit operations. These insurance costs are incorporated into the lease payments. In a purchase, insurance is the responsibility of the Government. To keep the purchase and lease options comparable, it is important to include the same insurance cost in both cases, regardless of whether the government actually purchases insurance. This was done in the UHF Follow-on program, where insurance costs were based on insurance industry forecasts and NASA data [Ref. 18: P. 3].

- **Financing**

Financing arrangements can also influence the outcomes of the purchase/lease cost analysis. In the lease option, there are both debt and equity portions if the lease is structured according to the leveraged lease concept. As has been explained in Chapter II, the lessor, Hughes, is the equity holder and remains the real owner of the property at the end of the lease period. The debt holder, as the third party in this leasing process, provides the debt financing for the asset. In this case, one option for the debt holder is the Federal Financing Bank (FFB) which offers subsidized rates for government guaranteed leases. Special financial arrangements, including leveraged leases and FFB financing make leases more attractive relative to purchases. To eliminate this distortion, innovative leasing strategies, including leveraged leases and FFB financing, were *not* considered. In addition to this, accelerated depreciation and ITC were *not* taken into consideration, due to both the uncertainty of their future tax status and realism of introducing them into the contractor's proposed tariff schedule. [Ref. 18: p. 1]

- **Launch costs**

Launch costs are another important consideration because they represent approximately 50 percent of the hardware cost of the satellite. In the purchase option, it is assumed that the government purchases the launch services. In the lease option, the lessor provides launch services. If the government and private users are charged different rates for launch services (*i.e.* if government agencies receive subsidized rates from NASA), it could distort the purchase/lease cost analysis. To eliminate this distortion, the same launch costs were used in both options.

3. Lease Versus Buy Cost Analysis

Table 4 on page 39 shows the key parameters taken into consideration by Navy [Ref. 19] and Booz, Allen and Hamilton Inc. [Ref. 18] in their lease versus buy analyses.

Table 4. KEY PARAMETERS OF ECONOMIC ANALYSIS

Parameters	*Navy Assumptions*	*Booz, Allen & Hamilton Inc.*
Number of Satellites	10	10
Satellite Unit Cost	$100 million	$91 million
Launch Cost/Satellite	$45 million	$45 million
Insurance (launch)	20%	20%
Insurance (on-orbit)	4%/year	4%/year
Annual Operation Cost	$11 million	$11 million
ROE on Exposed Funds	4% (buy) / 4% (lease)	15% (buy) / 4% (lease)
Fee to the Third Party	10% Fee on 4% Real Interest	10%
Discount Rate	3.32% (real)	7.175%
Operational Period	10 Years	10 Years
Satellite Design Life	14 Years	14 Years

Table 5 on page 40 shows the cost differences between the lease and purchase alternatives. In this table, Case I and III are based on Booz, Allen and Hamilton Inc. assumptions. Case I includes a 10 year lifetime, where Case III considers a 14 year system life. The Navy case is based on the Navy's assumptions.

Insurance A reflects a 20 percent premium for launch and initial coverage plus four percent per-year on orbit insurance costs for the declining value of the satellite. Insurance B reflects a 13 percent premium for initial coverage of satellites, with the government self insuring the launch in the case of the purchase option. Insurance B also includes the four percent per-year on orbit insurance for the declining value of the satellite.

Table 5. LEASE VERSUS BUY COST COMPARISON

CASES	UNDISCOUNTED		DISCOUNTED	
	Purchase	Lease	Purchase	Lease
I (Baseline)	1,598.9	2,034.1	1,101.0	971.0
I (With Residual Value)	1,438.0	2,034.1	1,054.1	971.0
I (With Insurance A)	2,031.1	2,568.7	1,353.6	1,226.2
I (With Insurance A & Residual Value)	1,870.1	2,568.7	1,306.7	1,226.2
I (With Insurance B)	1,877.4	2,372.0	1,258.6	1,132.3
I (With Insurance B & Residual Value)	1,716.4	2,372.0	1,211.6	1,132.3
III (w/o Insurance)	1,653.9	2,235.2	1,055.6	880.1
III (w/Insurance A)	2,086.1	2,765.0	1,260.5	1,088.7
Navy (w/Insurance A)	N/A	N/A	1,700.0	1,775.0

Using undiscounted values, Booz, Allen and Hamilton Inc. found the purchase option to be more expensive than the lease option in all cases. However, when values were discounted, the ranking reversed and the lease option became least expensive in all cases. Contrary to this, the Navy found the purchase option to be four percent less expensive than the lease option, using discounted values.

The critical factors affecting this decision are the discount rate and the interest rate charged on exposed funds (funds spent by the contractor but not reimbursed by the government). The discount rate is one critical assumption. The higher the discount rate, the more important the up-front cost differences while out-year cost differences become less important. Figure 6 on page 42 and Figure 7 on page 43 [Ref. 18: p. III-5-6] compare the undiscounted and discounted government cash flow for purchase and lease options. Because a lease reduces up-front expenditures and increases out-year expenditures, ***the higher the discount rate, the more attractive are leases.*** This is apparent from Table 5. On an undiscounted basis, the purchase option is less expensive than the lease. With 3.32 percent discount rate (in the Navy case)

lease and purchase costs are essentially equal. With a 7.175 percent discount rate, as in Cases I and III, a lease is less expensive than a purchase. Thus, the results of the purchase/lease cost analysis are very sensitive to the discount rate.

The interest changed on exposed funds is another critical parameter. For the purchase option, the contractor receives progress payments during the procurement process. Therefore, the contractor never has a significant amount of exposed funds. For a lease, the lessor does *not* receive lease payments until the government begins to receive service. Thus, the lessor incurs all procurement and launch costs before receiving payments from the government, exposing a significant amount of funds. Booz, Allen and Hamilton Inc. found that exposed funds reached a peak of $847 million in one of the lease option cases (Case I with Insurance A) [Ref. 18: p. II-17]. The higher the interest demanded by the lessor for these exposed costs, the less attractive a lease appears. Both the Navy and Booz, Allen and Hamilton Inc. assumed a four percent real interest rate on exposed funds for the lease option.

Finally, the tax law changes in 1986 eliminated the 10 percent ITC and accelerated depreciation. Without these tax benefits, the cost analysis favored a purchase by a four percent. The tax benefits could potentially have reduced the lease cost by the four percent margin.

4. Conclusions

Examining the UHF follow-on satellite program and its cost analyses, yields the following conclusions.

- **Costs**

In the discounted cost case, using Booz, Allen and Hamilton Inc.'s assumptions, a lease appears to be the least expensive option. Using the Navy's assumptions, a purchase is less expensive but the cost differential is

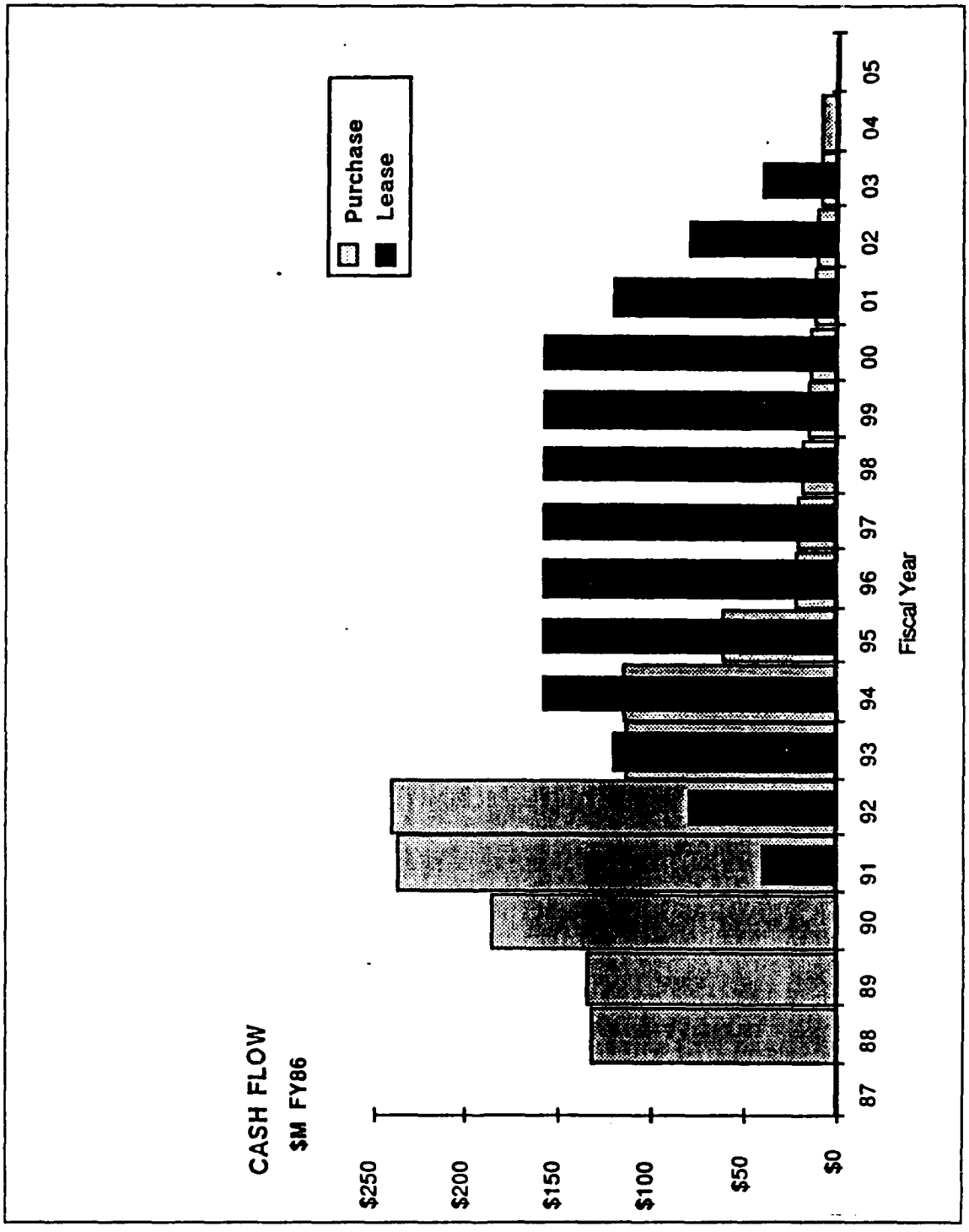

Figure 6. Government Cash Flow (Undiscounted)

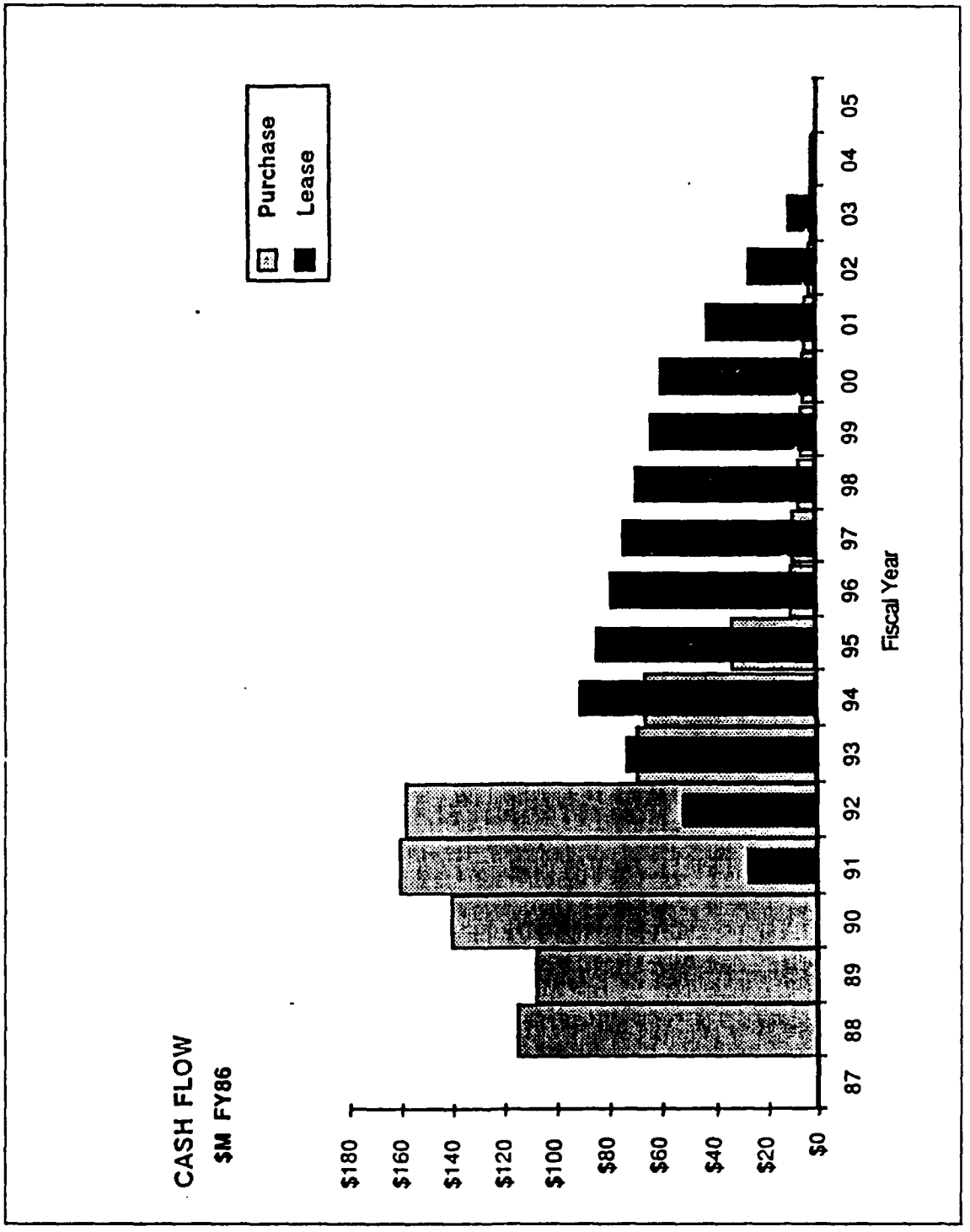

Figure 7. Government Cash Flow (Discounted)

insignificant (four percent). In the Navy's analysis neither option emerges as a clear choice on the basis of costs.

- **Sensitivity**

The analysis is sensitive to the assumptions made in the lease/purchase cost analysis. In particular, the discount rate turned out to be a very critical factor considering the cash flow profile. Interest on exposed funds is also critical. Other significant factors include system life, residual value, insurance costs, and launch costs. Given the comparability of costs in the Navy case, elimination of the tax benefits could have influenced the outcomes of the analysis.

- **Other factors**

The Navy decided to purchase rather than lease the UHF follow-on satellites due in part to the four percent cost difference. However, there are other important factors to consider. These factors include:

- technical sophistication
- tax law changes
- cash flow
- personnel requirements

The level of technical sophistication favors a purchase over a lease because it gives the government more flexibility to modify system specifications and shifts the risk of technical uncertainty to the government. Leases balance the government's cash flow requirements over the system's life. This is advantage for leases, especially where the budget constraints are tight. Finally, a lease reduces the government's management requirements. The lease/purchase decision must balance costs with these other factors.

V. CONCLUSIONS

The most important point in either purchasing or leasing a satellite communications systems, from the military, or more specifically the Navy's, point of view, is to get a continuous communication service, with adequate capacity and capability. In this study two basic methods were covered: one is the direct purchasing method where DOD appropriates enough funds to buy the system; the second is leasing the service or equipment.

In deciding whether to lease or purchase a system, several factors should be considered. One important factor is whether the service or hardware can be shared with other civilian and military users. The Navy will get some cost savings from a lease if the satellite can be a shared system.

The following issues should also be taken into consideration in making the lease or purchase decision:

- **Technical factors**
  - Whether the system uses proven or new, unused technologies.
  - Importance of technical flexibility
  - Importance of schedule/budget constraints
- **Managerial factors**
  - Staff requirements and control over the system
  - Risk bearing
- **Financial factors**
  - Cost effectiveness
  - Cash flow factors
  - Financial risk
  - Tax inducement

Prior to 1986, the U.S. tax code included tax incentives for U.S. industry, including the investment tax credit and accelerated depreciation, to encourage investment and enable companies to compete more effectively in the world market. These tax incentives were available to the satellite industry. These tax incentives created an apparent savings when the Navy leased a satellite system from the private sector. This encouraged leases as opposed to purchases. These tax incentives were eliminated in 1986.

In the LEASAT Program several factors favored leasing as the preferred acquisition. Cost and schedule constraints were very important. Technical capability and flexibility were less important enabling the system to use proven technology and performance specifications. Risks were moderate, enabling them to be shifted from the government to the private sector. [Ref. 3: p. 12] Finally, tax laws at the time made leasing appear less expensive than it actually was.

Considering these factors, leasing was selected in the LEASAT program as the best alternative. Analysis of this decision indicates that factors other than lowest cost are important in lease/buy decisions.

Conditions are different in the UHF follow-on satellite program. Technical capability has received increased priority. This favors state-of-the-art technology and technical specifications. Cost and schedule, while still important constraints, appear to have a lower priority relative to technical capability. Finally, the tax laws have eliminated the perceived savings previously attributed to leases. Considering these factors, the Navy decided to purchase the UHF follow-on system. If the tax laws had *not* changed, it is likely that leasing would have been ***comparable to*** or ***cheaper*** than purchasing. However, it is impossible to determine if cost considerations would have led the Navy to change their decision.

APPENDIX A. ABBREVIATIONS AND ACRONYMS

ACR	Accelerated Cost Recovery
ACRS	Accelerated Cost Recovery System
AFSATCOM	Air Force Satellite Communications
AFSCF	Air Force Satellite Communication Facilities
AT&T	American Telephone and Telegraph
COMSAT	The Communication Satellite Corporation
CSA	Communications Service Authorization
DOD	Department of Defense
EHF	Extremely High Frequency
FFB	Federal Financing Bank
FLTBCST	Fleet Broadcast
FLTSATCOM	Fleet Satellite Communications
FY	Fiscal Year
GAO	General Accounting Office
GAPSAT	Gapfiller Satellite
IBM	International Business Machine
IRS	Internal Revenue Service
IRR	Internal Rate of Return
ITC	Invesment Tax Credit
INTELSAT	International Telecommunications Satellite Organization
JCS	Joint Chiefs of Staff
KHZ	Kilohertz
LEASAT	Leased Satellite
MARISAT	Maritime Satellite
MILSAT	Military Satellite Communications
NASA	National Aeronautics and Space Administration

PC	Personal Computer
PDV	Present Discounted Value
PPBS	Planning, Programming and Budgeting System
PTT	Postal, Telegraph and Telephone
R&D	Research and Development
ROE	Return On Equity
SHF	Super High Frequency
SPAWAR	Space and Naval Warfare Systems Command
TDRSS	Tracking and Data Relay Satellite System
UFO	Ultra High Frequency Follow-on
UHF	Ultra High Frequncy
U.S.	United States
USAF	United States Air Force
WESTAR	Western Union Satellite

APPENDIX B. SERVICE DIFFERENCES BETWEEN LEASAT AND FLTSAT

Each FLTSATCOM satellite is hardened to JCS criteria and has a total of 23 channels operating at UHF frequencies, plus a single SHF uplink channel for Navy Fleet Broadcast (FLTBCST). Specifically, the UHF channels are: one 25 KHz channel for FLTBCST downlink, nine general purpose relay channels serving both secure voice and teletype/data user networks, one DOD wideband (500 KHz) channel, plus seven 5 KHz channels for USAF forces, and five 5 KHz channels for general USAF use. The latter 12 5 KHz channels are included within the AFSATCOM program and, together with the 500 KHz wideband channel, are managed by the USAF, while the remainder are managed by the Navy.

On the other hand, the LEASAT satellites have a total of 13 channels. As in the FLTSATCOM satellite, there is provided a single SHF uplink, a UHF downlink channel for FLTBCST, plus a total of six 25 KHz channels, four for Navy use and two for Army Ground Mobile Forces. In addition, LEASAT contains a DOD wideband (500 KHz) channel plus five 5 KHz channels for USAF AFSATCOM use.

APPENDIX C. LEASAT CONTRACT N00039-79-0011:

1. Hughes has from the outset depended from a technical and financial standpoint upon the availability of launch services by Space Shuttle. The Navy has known this.

2. Hughes has informed the Navy that, because of Shuttle program delays. Hughes is unable to perform according to the contract schedule and its planned financing is unavailable. Hughes has represented that its investment to date under the LEASAT Contract is approximately $116 million, that development is essentially complete, substantially all parts and materials are on hand, and assembly and tests have progressed satisfactorily. Hughes has informed the Navy that it has been forced virtually to suspend production and to place the LEASAT program in a caretaker status due to the Shuttle delays and their impact upon the prospects now virtually non-existent, of obtaining leverage financing to obviate the high interest rates attributable to the aforesaid investment.

3. After conclusion of whatever Space Shuttle test flights are necessary to reveal a reliable schedule for Shuttle launches, Hughes and the Navy will agree upon revised dates for commencement of communication services. These dates shall be as early as practicable, taking into account the time reasonably required for Hughes to complete satellite production and to coordinate with the Shuttle launch schedules.

4. In the event the agreement specified in section three can not be reached on or before November 1, 1981, the rights and remedies of Hughes and the Navy will be determined on the basis of the LEASAT contract, as though this Aide

Memoire had never been agreed to and executed, and written notice of this event shall be given by the Navy to Hughes.

5. Hughes will be obliged to provide communication services beginning at any time designated by the Navy within the first three years following the agreed upon dates for commencement of communication services, it being understood, however, that the Navy shall make its designation of its anticipated timeframe at the earliest practicable date in order to permit Hughes to formulate its construction schedule in conformity with such designation. Moreover, the Navy shall give Hughes 120-day notice of the precise date for commencement of communication services by Hughes. Hughes shall be entitled to no additional payment if the Navy designates dates for commencement of communication services after dates agreed to pursuant to section three, provided, however, that the Navy will bear any launch costs in excess of costs that would have been incurred for launches at the agreed upon commencement dates.

6. The Navy shall have the option upon one year's notice to increase in-orbit services from five to six or seven years, at unit prices per year and per satellite of $20 million. The Navy also will be provided the option to purchase any of one to four satellites after seven years of in-orbit service at $15 million per satellite.

7. Hughes will receive an initial payment of $67 million at the time revised dates for commencement of communication services are agreed to under section three. Later payments will be made pursuant to the following funding profile.

Fiscal year:

1983	$55
1984	$55
1985	$40
1986	$40
1987	$40
1988	$38

The payments in fiscal year 1983 and fiscal year 1984 shall be made in full during the first quarters of those fiscal years. In the event Hughes is able to obtain the leverage financing referred to in section two, or in the event Hughes can delay for a period in excess of 90 days the construction schedule it has planned to meet launch dates in December 1983, June 1984, December 1984, and June 1985, the parties shall reexamine the above funding profile, this for the purpose of ensuring that the relationship between the funding profile and the costs incurred by Hughes is kept in equitable balance. In addition to the payments set out above, if the Navy exercises all or any part of its option rights provided for in section 6, Hughes shall be entitled to $20 million during each additional year of service by each satellite, and $15 million upon the purchase, if any, of each satellite. If the Navy purchases one or more satellites, Hughes shall provide tracking, telemetry and control services throughout the remaining life of the satellite or satellites, for which the Navy will pay $5.4 million during each year such services are provided.

8. The Navy shall continue payments on the schedule set out in section seven unless and until the Navy concludes that it will not receive communication services to which it is entitled. In such an event the Navy shall have the right to discontinue its payments, and to recoup all payments unearned by Hughes under the contract and Hughes shall have an absolute obligation to repay those payments. However, if the reason for Hughes's failure to provide such communication services is the inability, by reason of delay or cancellation of

the Space Shuttle program, to meet the dates for commencement or continuation of services agreed to pursuant to sections three and five, Hughes shall have such rights to recover its incurred costs as may be determined on the basis of the LEASAT contract, as though this Aide Memoire had never been agreed to and executed.

9. Hughes shall provide security and full audit rights satisfactory to the Navy.

10. The Navy and Hughes will promptly proceed to negotiate contract modifications and such other documents as are necessary to implement this Aide Memoire. Any payments by the Navy pursuant to such modifications and implementing documents shall be subject to the availability of appropriations for this purpose.

HUGHES AIRCRAFT CORP. & HUGHES
COMMUNICATION SERVICES, INC.,
BY ALLEN E. PUCKETT,
Chairman of the board and Chief Executive Officer.

DEPARTMENT OF THE NAVY,
BY EDWARD HIDALGO,
Secretary of the Navy.

Dated: January 5, 1981.

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